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Engineering is a profession likely to attract the individual who seeks direct, sure lines to follow in life where he can avoid the tension of ambiguous or novel ideas, the sensitive encounters of interpersonal relations, and can derive satisfaction from tangible accomplishments. The supposition is that this individual, regardless of ability or social class, is attracted to engineering more than to non-technical professions and is relatively restricted in the roles he identifies with and in his life style. To explore this contention, the personality characteristics and reported opinions of engineering majors were investigated in order to compare their modes of thinking and attitudes with those observed among liberal arts majors. Several attitudinal scales were administered to graduates in 1959 and 1963 and scores were computer to yield measures of intellectual disposition, manifest anxiety, and autonomous, open and flexible thinking. The engineering and liberal arts majors, all of whom had persisted in college 4 years, were then compared on these measurements. Opinions expressed through questionnaire responses were also compared. Each of the study's hypotheses--most of which were related to the less intellectual and less flexible nature of the engineering major--was supported by the data observed. Selected data are contained in the attached tables. (JS)

# DISPOSITIONAL DIFFERENCES BETWEEN TECHNOLOGY AND LIBERAL ARTS MAJORS

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# Dispositional Differences Between Technology and Liberal Arts Majors*

(Abstract)

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Radical changes in our socioeconomic system are imminent due to the advent of automation. These changes will involve many complex decisions on the part of a large segment of society, and an understanding of the nature of the members of society who will be affected by these decisions. Technologists in particular will be responsible for many of the decisions affecting society and its economic system. Consequently, it is important to have some knowledge of their intellectual and social values and attitudes.

Recently considerable attention has been given specifically to the characteristics of engineering students and their curricula. In essence, evidence exists that engineers compared to students and individuals in non-technical fields and professions, on the average, are unduly rigid and stereotyped in their thinking, excessively practical-minded and correspondingly averse to intellectual activities, and unable to appreciate the roles and people not in their realm of preference.

Among the reasons suggested as accounting for the engineer's relatively inflexible and non-intellectual disposition is his socioeconomic background. Argument has been presented that the engineer comes disproportionately from low socioeconomic strata. But is is characteristic of individuals of low socioeconomic backgrounds who are upwardly mobile to seek out those professions which are liable to lead them most quickly to a state of affluence, particularly when ability is no barrier. Thus bright men of low social status would naturally tend to enter engineering. They have the mental potential to succeed in the profession, the profession is a relatively lucrative one, and it does not entail involvement with ideas which are liable to be alien to those individuals from low socioeconomic backgrounds.

No doubt such an argument is relevant in the case of many engineers, but it does not appear to be all-inclusive. From the beginning it does not account for the motives or dispositions of engineers from high socioeconomic backgrounds. Nor does the argument take sufficiently into account the nature of the field itself. As the individual is attracted to certain professions, the individual profession holds an attraction for certain individuals.

Engineering is a profession likely to attract the individual who seeks out direct, sure lines to follow in life, where he need not be confused with the tensions or anxieties of conflicting or ambiguous or novel ideas, where he can avoid the sensitive encounters of interpersonal relations, and where he can derive satisfaction from the observable, tangible accomplishments of the more routine doing that ar less

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apparent in the more abstract professional roles. This kind of individual can be found at any ability level or any socioeconomic level. The supposition is that, regardless of ability or social class, he is attracted to the engineering profession more than to non-technical professions. The typical engineer may be regarded in this light as an individual who is relatively restricted in the roles he identifies with and who seeks a profession which is compatible with his more narrow life style. The present paper was undertaken in order to explore these suppositions futher.

## Problem and Procedure

The purpose of the paper is to investigate on a broad base measured personality characteristics and reported opinions of engineering majors in order to compare their modes of thinking and attitudes with those observed among liberal arts majors. The data were obtained in the course of a five-year longitudinal study of 10,000 high school graduates of 1959 conducted at the Center for the Study of Higher Education, University of California, Berkeley. Several attitudinal scales from the Center's Omnibus Personality Inventory were administered to the graduates in 1959 and 1963. The students' standard scores on these scales were computed to yield measures of intellectual disposition, manifest anxiety, and autonomous, open, and flexible thinking. The students majoring in the different fields were then compared on these measurements. Pertinent opinions expressed by these students through questionnaire responses were also compared. All analyses were restricted to men majoring either in the liberal arts or engineering and who persisted in college for four years. In this way, the effects of sex differences, attrition, and the possible idiosyncracies of "semi-technical" fields were eliminated.

## Hypotheses

The analyses center around a number of hypotheses which presumably follow from the suppositions underlying the present paper in reference to a comparison of male liberal arts and engineering majors:

1. The engineers will identify more with practical and masculine roles, and less with cultural and intellectual roles, in terms of themselves, others, work, and education.

2. The engineers will be less intellectual and flexible in disposition and manifest less anxiety on the basis of measured attitudes.

3. The engineers will change less in a flexible, open-minded and intellectually oriented direction after four years of college.

4. Engineers who persist in their field for four years will be less intellectual and flexible than students who defect from engineering to the liberal arts.

5. These differences will exist regardless of level of ability or socioeconomic status.

Summary of the Findings

The findings of the study will be summarized in reference to the hypotheses, each of which was supported by the data observed. Selected data may be found in the attached tables.

1. On the basis of questionnaire responses, the engineers, when compared to the liberal arts students, considered themselves proportionately much less as intellectuals, liberals, and leaders, and more as conformists and conservatives; they reported as much "intellectual growth" on their part as the result of college, but were less prone to report having had intellectually stimulating teachers, and were less concerned over their studies being too bound by course requirements or unpermissive rules; they placed more emphasis on the practical contribution of scientists and were less sympathetic towards people involved in modern movements in art and literature; they viewe the most important factor of a job more as a source for opportunity and enjoymen: and less as something to take pride in or a vehicle through which to help others; they were more sure about their vocational choices, and made them earlier; they viewed the purpose of education more as vocational training and much less as fostering knowledge and the appreciation of ideas. In sum, the engineers identified proportionately more with expedient, practical and masculine roles and considerably less with intellectual and cultural roles when compared with the liberal arts men.

2. Three attitudinal scales from the Omnibus Personality Inventory were combined as a measure of intellectual disposition assessing one's tendency toward abstract, reflective thinking, intellectual curiosity, tolerance for ambiguity, and interest in artistic matters. Students were categorized at high, middle, and low levels on this "intellectuality scale" (Table 3). The large majority of the engineers (twice as many as liberal arts students) were at the low level of intellectuality. Three times as many liberal arts men as engineers were at the high intellectuality level. Similarly, engineers were much less flexible and open-minded in their thinking as measured by the Autonomy scale. The differences between the means for the two groups expanded one half a standard deviation. Therefore, the engineers were observed as both much less intellectually oriented and much less autonomous, flexible, and open in their thinking compared to the liberal arts students on the basis of measured attitudes. The engineers also manifested less anxiety than the liberal arts men. This finding corresponds with the thesis that engineers tend to seek out their profession in part by way of avoiding the anxiety of ideological conflict. However, cause and effect relations were not directly examined in this paper.

3. A number of the Omnibus Personality Inventory scales were administered to the sample in 1959 and again in 1963. As a result it was possible to gauge changes in the groups' scores over a period of four years. The engineers, who were lower in intellectual disposition and autonomy to begin with, compared to the liberal arts men, also showed less change in their mean scores than did the liberal arts students. On the Complexity scale, which assesses intellectual curiosity and tolerance for ambiguity, the engineers' mean score was actually deflated slightly after four years. It would thus appear that the engineers who are more constricted in outlook are also less prone to change in outlook.

4. A thesis of this paper has been that individuals more constricted in outlook may be more likely to choose engineering since this field is more given to impersonal "routine doing" than intellectual or interpersonal foment. But then it would follow that autonomous individuals not so intellectually constricted would find engineering to be incompatible, and therefore seek out other professions. The measured attitudes of students who began their college career as engineers, but who later defected to the liberal arts were compared to the attitudes of students who remained consistently in engineering and the liberal arts (Table 6). The defectors were not as intellectually disposed as the persisting liberal arts students, but they were much higher in intellectual disposition than the persisting engineers. The defectors were also much more flexible and open-minded in their thinking than the persisting engineers. In fact, the defectors' mean Autonomy score nearly duplicated that of the persisting liberal arts men. Therefore, on the basis of group data, evidence exists that the engineering profession loses a disproportionate amount of its most intellectual and innovative thinkers.

5. Background data were available which allowed all the students to be categorized by level of ability and socioeconomic status (Tables 1 and 2). All measured personality differences and types of questionnaire responses were examined by ability and socioeconomic level. In no instance were the patterns of differences between the two major groups appreciably affected by differences in ability or socioeconomic status (see, e.g., Tables 4 and 5). It may be of particular significance that differences in socioeconomic status failed to account for other differences between the engineering and liberal arts students since in the past this factor has represented a major attempt to explain the engineers' relatively narrow outlook.

The fact remains that the engineers do appear constricted in outlook, whether on the basis of expressed opinion, value, or measured attitude, and whether the engineers are of exceptionally high or low ability, or are from a high or low socioeconomic background. A central thesis of this paper appears to have been substantiated in a variety of ways; namely, that the profession of engineering, itself, disproportionately attracts and supports individuals, who, for whatever reasons, prefer to avoid ideas, innovations, and inter-personal commitments. However, individual differences varied widely within each group, and the two major groups generally overlapped considerably on the variables examined.

Table 1. Percentage of the Engineers and Liberal Arts Men at Each Ability Level

| Major group | No. | Ability level | | | |
|---|---|---|---|---|---|
| | | High | Middle | Low | No ability information |
| Engineering | 107 | 70 | 23 | 4 | 3 |
| Liberal arts | 376 | 66 | 24 | 7 | 3 |

Table 2. Percentage of the Engineers and Liberal Arts Men at Each Socioeconomic Level

| Major group | No. | Socioeconomic level | | | |
|---|---|---|---|---|---|
| | | High | Middle | Low | No information |
| Engineering | 107 | 23 | 60 | 13 | 4 |
| Liberal arts | 376 | 30 | 56 | 10 | 4 |

Table 3. Percentage of the Engineers and Liberal Arts Men at Each Intellectuality Level

| Major group | No. | Intellectuality level | | | |
|---|---|---|---|---|---|
| | | High | Middle | Low | No information |
| Engineering | 103 | 7 | 28 | 65 | 0 |
| Liberal arts | 376 | 25 | 35 | 38 | 2 |

Table 4. Percentage of the Engineers and Liberal Arts Men at Each Intellectuality Level by Ability Level

| Ability level and major group | No. | Intellectuality level | | | |
|---|---|---|---|---|---|
| | | High | Middle | Low | No intell. information |
| High | | | | | |
| Engineering | 75 | 9 | 27 | 59 | 5 |
| Liberal arts | 249 | 28 | 34 | 36 | 2 |
| Middle | | | | | |
| Engineering | 25 | 0 | 28 | 72 | 0 |
| Liberal arts | 92 | 14 | 33 | 48 | 5 |
| Low | | | | | |
| Engineering | 4 | 0 | 25 | 75 | 0 |
| Liberal arts | 25 | 20 | 48 | 32 | 0 |

Table 5. Percentage of the Engineers and Liberal Arts Men at Each Intellectuality Level by Socioeconomic Level

| Socioeconomic level and major group | No. | Intellectuality level | | | |
|---|---|---|---|---|---|
| | | High | Middle | Low | No intell. information |
| High | | | | | |
| Engineering | 25 | 8 | 32 | 60 | 0 |
| Liberal arts | 111 | 31 | 31 | 36 | 2 |
| Middle | | | | | |
| Engineering | 64 | 8 | 20 | 66 | 6 |
| Liberal arts | 212 | 22 | 40 | 36 | 2 |
| Low | | | | | |
| Engineering | 14 | 0 | 43 | 57 | 0 |
| Liberal arts | 36 | 14 | 31 | 50 | 5 |

Table 6. Mean Standard Scores on Selected Omnibus Personality Inventory Scales Obtained by Persisting Engineering Majors, Engineers Who Defected to Liberal Arts Majors, and Persisting Liberal Arts Majors

| (Number) | Persisting engineers (81) | Defectors to lib. arts (50) | Persisting lib. arts (130) |
|---|---|---|---|
| Thinking introversion | 48 | 53 | 58 |
| Complexity | 50 | 53 | 55 |
| Estheticism | 43 | 48 | 53 |
| Autonomy | 50 | 54 | 55 |